Claims

[c1] A steam turbine comprising a steam inlet pipe coupled to a steam inlet port in a steam turbine housing, at least a portion of said steam inlet pipe fabricated from at least one of a shape memory alloy having a memorized activated configuration, and a negative thermal expansion ceramic having an activated configuration.

[c2] A steam turbine in accordance with Claim 1 wherein said shape memory alloy is transformable from a martensitic state to an austenitic state, said portion of said steam inlet pipe restorable from an initial configuration to said memorized configuration at a temperature at which said shape memory alloy transforms to said austenitic state.

[c3] A steam turbine in accordance with Claim 1 wherein said portion of said steam inlet pipe fabricated from at least one of a shape memory alloy and a negative thermal expansion ceramic comprises a straight section of said steam inlet pipe.

[c4] A steam turbine in accordance with Claim 3 wherein said straight section comprises an initial configuration having a first length at a first temperature and an activated configuration having a second length at a second temperature, said first length greater than said second length and said first temperature less than said second temperature.

[c5] A steam turbine in accordance with Claim 4 wherein a difference between said first length and said second length of said straight section approximately equals an increase in length of the remainder of said steam inlet pipe due to an increase in temperature of said steam inlet pipe.

[c6] A steam turbine in accordance with Claim 1 wherein said portion of said steam inlet pipe fabricated from at least one of a shape memory alloy and a negative thermal expansion ceramic comprises an elbow section of said steam inlet pipe.

[c7] A steam turbine in accordance with Claim 6 wherein said elbow section is fabricated from a shape memory alloy and comprises an initial configuration having an initial elbow angle at a first temperature and a memorized

configuration having a memorized activated elbow angle at a second temperature, said first temperature less than said second temperature, said first temperature less than a temperature at which said shape memory alloy transforms to an austenitic state, and said second temperature equal to or greater than a temperature at which said shape memory alloy transforms to said austenitic state, said memorized activated elbow angle different from said initial elbow angle, said memorized activated elbow angle selected to reduce stress on said turbine housing caused by thermal expansion of said steam inlet pipe.

[c8] A steam turbine in accordance with Claim 1 wherein said shape memory alloy comprises an alloy of nickel and titanium or an alloy of copper and aluminum.

[c9] A steam turbine in accordance with Claim 8 wherein said shape memory alloy comprises at least one of NiTi, NiTiCu, CuZnAl, CuAlNi, NiTiFe, CuAlNiTiMn, TiNiPd, TiNiPt, NiTiPd, and TiNiHf.

[c10] A steam turbine in accordance with Claim 1 wherein said negative thermal expansion ceramic comprises at least one of ZrW_2O_8 and ZrP_2O_7.

[c11] A method of controlling forces exerted on a steam turbine by a steam inlet pipe, the steam turbine comprising a steam inlet pipe coupled to a steam inlet port in a steam turbine housing, said method comprising:
fabricating at least a portion of the steam inlet pipe from at least one of a shape memory alloy having a memorized activated configuration, and a negative thermal expansion ceramic having an activated configuration;
installing the steam inlet pipe with the at least a portion of the steam inlet pipe in an initial configuration at a first temperature; and
heating the at least a portion of the steam inlet pipe with steam flowing into the steam turbine to a second temperature which reconfigures the at least a portion of the steam inlet pipe to the activated configuration.

[c12] A method in accordance with Claim 11 wherein installing the steam inlet pipe comprises installing the steam inlet pipe with the portion of the steam inlet pipe fabricated from at least one of a shape memory alloy and a negative thermal expansion ceramic comprising a straight section of the steam inlet pipe.

[c13] A method in accordance with Claim 12 wherein the straight section comprises an initial configuration having a first length at a first temperature and an activated configuration having a second length at a second temperature, the first length greater than the second length and the first temperature less than the second temperature.

[c14] A method in accordance with Claim 13 wherein a difference between the first length and the second length of the straight section approximately equals an increase in length of the remainder of the steam inlet pipe due to an increase in temperature of the steam inlet pipe.

[c15] A method in accordance with Claim 11 wherein the portion of the steam inlet pipe fabricated from at least one of a shape memory alloy and a negative thermal expansion ceramic comprises an elbow section of the inlet pipe.

[c16] A method in accordance with Claim 15 wherein the elbow section is fabricated from a shape memory alloy and comprises an initial configuration having an initial elbow angle at a first temperature and a memorized configuration having a memorized activated elbow angle at a second temperature, the first temperature less than the second temperature, the first temperature less than a temperature at which the shape memory alloy transforms to an austenitic state, and the second temperature is equal to or greater than a temperature at which the shape memory alloy transforms to the austenitic state, the memorized activated elbow angle different from the initial elbow angle, the memorized activated elbow angle selected to reduce stress on the turbine housing caused by thermal expansion of the steam inlet pipe.

[c17] A method in accordance with Claim 11 wherein said shape memory alloy comprises an alloy of nickel and titanium or an alloy of copper and aluminum.

[c18] A method in accordance with Claim 17 wherein the shape memory alloy comprises at least one of NiTi, NiTiCu, CuZnAl, CuAlNi, NiTiFe, CuAlNiTiMn, TiNiPd, TiNiPt, NiTiPd, and TiNiHf.

[c19] A method in accordance with Claim 11 wherein the negative thermal expansion ceramic comprises at least one of ZrW_2O_8 and ZrP_2O_7.